**Assignment:**

Sam has received medical approval for participation in an intensive exercise program. Your final assignment for this module is to design an evidence-based intervention to improve Sam’s balance, gait, and/or fitness. You may focus on any or all of these areas, as long as you explain your rationale and provide evidence to support your plan. Address **all 4 areas** (Parts A through D) below (expected length 4-5 pages, double spaced; due by midnight on Tuesday, March 25).

1. **Review Sam’s case history from the PowerPoint presentation. The measures of Sam’s current perceptual and motor impairments and his physical function should provide a basis for intervention planning. Were the tests and measures used adequate for this purpose? If not, what additional information is needed?**

Information obtained from the provided test results: (1) Body function: Sam has scored less in both lower extremity motor performance (Fugl-Meyer) 1 and has unilateral spatial neglect (with star cancellation score less than the cut off score of 40/54)5,29; (2) Activity: Sam is currently able to ambulate only within household (<0.4 m/s) 30 and has poor standing balance (Berg Balance Score (BBS) < cut off score of 45/56)1. BBS does not help to assess falls, therefore an assessment measure for falls will be needed.7 Sam presents with significantly low level of confidence in functional mobility and has increased fear of falling ( Activities Specific Balance Confidence (ABC)Scale significantly < 81.1) 1. ABC here helps to measure those functional gains, that BBS cannot, which are needed for community re-integration and leisure participation7; (3) Participation: Sam is at increased risk for falls (Step test < cut off score of 10) 1, 7. Also, stroke seems to have greatly affected his quality of health and life (based on Stroke Impact Scale (SIS) scores) 1, 29.

Suggested Tests to provide further information:

1. Body function: (a) Beck Depression Inventory: With cut-off score at <10 has good specificity and sensitivity at 12 months, post-stroke for depression screening. Depression is frequently seen post-stroke and limits functional progress2, 6, 18 and Sam is already taking anti-depressants (Prozac). (Referral to Psychiatrist, if needed); (b) Catherine Bergego Scale: Excellent psychometrics3. To assess, personal, extrapersonal, motor and representational neglect, not assessed by above tests for unilateral neglect.3,5 ; (3) Montreal Cognitive Assessment (MoCA):Impairment of cognitive status greatly affects functional status2. MoCA is better at identifying cognitive deficits, especially pertaining to executive function, recall, repetition, and attention with mild cognitive deficit that may be missed by Mini Mental Status Examination; (4) Strength Assessment: Assessment with dynamometer or with Medical Research council 0-5 grade is not reliable for measuring strength in Individuals With Stroke (IWS) 22. Author, based on the researched literature, was unable to find a suitable strength assessment technique for IWS; (5) ROM assessment.
2. Activity: (a) Functional Gait Assessment (FGA): Dynamic Gait Index (DGI) is highly recommended by StrokEDGE for IWS > 6 months1, however, FGA has been found to have better psychometrics compared to DGI, in being able to assess postural instability with walking tasks.8; (2) 6- min walk test: None of the above measures, assess aerobic capacity for Sam and for this 6 min walk test has been highly recommended by StrokEDGE in >6 months.1 Also, low score (<250m) has been found to indicate decreased community mobility.4 ; (3) Graded exercise testing: 6 min walk test may be used as for submaximal exercise testing.1 Sam may be referred to physician/ exercise physiologist for testing based on AHA guidelines, with an electrocardiogram, to ensure that he can participate in high intensity aerobic exercises.2
3. Participation: (1) IWS frequently suffer from Post-stroke fatigue that may cause decreased participation in functional activity.18 According to StrokEdge, Modified fatigue impact scale and Borg’s scale of perceived exertion are not recommended for fatigue assessment with IWS.9

In addition to above mentioned, family support2, patient’s barriers to participation (e.g. increased cost, longer distance) 28, the leisure social activities (to decrease social isolation) that Sam enjoys, and occurrence/frequency of past falls4, should be inquired into.

1. **What are the key factors to take into consideration in order to maximize the safety and effectiveness of your intervention for Sam? These may include factors related to pathology/comorbidities, impairments, medications, etc. How will you monitor Sam to try to insure his safety when exercising**

A proper understanding of Sam’s past medical history and information about any recent exercise testing reports should be obtained. Key factors that should be taken into consideration include:

(1). Presence of spatial neglect may lead to increased incidence of falls with walking and unsafe walking and wheelchair mobility.3,5 Sam may present with a delayed ability to “respond, orient, or initiate action” on the affected side, resulting in impaired functional mobility.3

(2) Osteoporosis: Long term use of proton pump inhibitors (>1 year) – Nexium and Protonix, can lead to osteoporosis.24 Lack of ‘sufficient’ functional mobility after stroke, also, leads to muscle disuse and osteoporosis. 2,20 Inability to protect oneself with outstretched hand on the paretic side and postural instability may, further, lead to increased falls that may lead to fractures. Hip fractures, furthermore, increase risk of mortality. 20 Hip protectors have been suggested by Poole et al, to avoid hip fractures, though in their review, they found poor patient compliance with the same. 20

(3) Cognitive deficits: Presence of cognitive deficits may impair functional performance and rehabilitation gains.2

(4) Depression: Chances of worsening of depression exist, with Neurontin. 24 Lower self-efficacy may be present in Sam with respect to functional mobility, due to depression.18 Depression can lead to post-stroke fatigue.2 And, a combination of pain (shoulder pain in Sam), depression, and fatigue, may lead to low quality of life.18

(5) Post-stroke Fatigue: Antidepressants can increase post stroke fatigue and sleep disturbances.2 Overall energy expended by Sam will be more for walking than healthy counterpart. 2 Sam may get fatigued before reaching maximum workloads or maximum heart rate response.2

(6) Baseline medical status and associated health challenges: Stroke may lead to development of vascular abnormalities in lower extremities that may lead to risk of thrombosis. 2 Increased energy demands with functional mobility and pre-existing cardiac disease may lead to severe cardiac complications. 2 Sam is also at a high risk for stroke, due to h/o stroke. 2 Presence of existing shoulder pain may also limit activity participation in daily life.

(7) Medications: Author will be referring Sam back to the physician, to ensure that he is on currently needed medications only and that he is having them in the right dosage. Following are some medication related issues that author noticed: (a) ACE inhibitor and KCL, together are unsafe and cause hyperkalemia that may lead to “kidney failure, muscle paralysis, irregular heart rhythm and/ or cardiac arrest”.24; (2) With renal issues, Sam’s dosage for appropriate dosing of magnesium oxide is needed, to prevent further complications. 24; (3) Atenolol and insulin, when taken together lead to hypoglycemia, if not in appropriate doses.24;(4) Sam is taking an anti-epileptic (Neurontin)24, without having epilepsy in past medical history; (5) Sam is on 2 Proton-pump inhibitors – Nexium, Protonix.24 Does he need both?; (6) Celebrex can worsen existing HTN for Sam and may increase risk for recurrence of stroke and occurrence of heart attack.24; (7) Allopurinol and Coumadin, when taken together, may cause increase in anti-coagulation action of latter.24 Appropriate dosing needed24; and (8) Sam is not on any oral bisphosphonates or Vitamin D supplementation, to counteract osteoporosis with stroke.20

With Sam, during exercises it is important to monitor the following: (1) Possible signs of hyperkalemia, due to drug interactions.24; (2) Hyoglycemic episodes due to interactions between atenolol and insulin.24 Patient education on regular monitoring of glucose levels is needed. 24; (3) Being on Atenolol (Beta blocker) may alter Sam’s ability to reach Maximum heart rate (HRmax), as it tends to slow heart rate changes with exercise. 21,24 HRmax and systolic Blood Pressure(BP) observed in Sam, will be decreased than normal. 21; (4) Beta blockers may, also, affect thermoregulation. 21; (6) Family education is needed on need to monitor mood changes, worsening of behaviors, and suicidal thoughts (due to, Neurontin and Prozac) 18,24; (7) Monitor INR, before starting therapy session (due to, Coumadin intake).24 INR> 4 indicates high risk of bleeding.24 During regular session, be extra careful to avoid any skin breakdown and possible bleeding.

**(c) Provide a detailed description of your intervention, including: frequency, intensity, and duration; examples of specific exercises and activities; and structure of a typical exercise session. Explain how you applied motor learning principles in the design of the program**.

Author strongly feels that physical activity, gait training and balance training are intricately associated with each other and that absence of any one of these, will result in an incomplete exercise program for Sam. However, for question (c) and (d), for this paper, author would like to focus on walking alone, with focus mainly on improving gait speed.

For a healthy individual, community ambulation requires 1.1 to 1.5 m/s gait speed.12 Perry et al. identified that in IWS, if walking speed is < 0.4m/s, IWS will be limited to household ambulation; between 0.4 to 0.8 m/s, IWS will be having limited community ambulation; and with >0.8 m/s, they will be able to ambulate in community, with no restrictions.1,30 Thus, currently Sam is limited to household ambulation. Interestingly, in a recent Cochrane review (2014), it was found that Body Weight Support Treadmill Training (BWSTT) or without BWS, did not improve the independence with walking in IWS.14 However, Treadmill training (TT) with or without BWS, compared to non-TT, produced significant gains with walking speed and endurance in IWS.14 Many studies have been performed with TT to understand the frequency, intensity and duration that would help in improving gait speed.11,12,15 However, according to the Cochrane review, no recommendations are available at this time and further research is needed to determine the exact Frequency (F), Duration (D), and Intensity (I) for TT with or without BWS for IWS, for achieving improvements with gait speed.14 Hence, due to lack of established parameters14 and increased variance in the training parameters used by the different studies11,12,15, the following parameters of F, I, and D, are based on the AHA guidelines, provided by Gordon et al.

Walking: F = 3-7 days/week; I= 40-70% Peak Oxygen uptake (VO2peak), 40-50% Heart Rate Reserve (HRR), 50-80% Maximal Heart Rate (HRmax), RPE 11-14 (6-20 scale); and D = 20-60 minutes/day.2

Strength training: F = 2-3 days/ week; I = 1-3 sets of 10-15 repetitions for each major muscle group; and D = as long as it takes to get 8-10 muscles done. 2

Flexibility: F = 2-3 days/ week; I = Based on authors clinical experience, per end-feel assessment; and D = Each stretch 10-30 seconds. 2

Examples of specific exercises and activities: TT and over-ground walking, with and without BWS. 2 Strength training with circuit training, free weights, weight machines, isometric exercises, for following muscle groups – knee flexors, knee extensors, ankle plantar flexors, hip flexors, especially on the paretic side.2,15,17,30 Flexibility exercises for all major muscle groups2 of lower extremity and trunk. Caregiver education on the goals, current ability and safety issues for the patient, to overcome barriers and improve patient participation. 2 Inclusion of caregiver (possibly spouse) in therapy programs, to ensure patient adherence and success of rehab program.2

Structure of Typical exercise session: Depending upon Sam’s level of deconditioning, initially small periods of sessions of walking and lower resistance levels (with, eccentric contraction followed by concentric contractions17), will be introduced.2 Each session will start with TT with BWS, followed by strength training (2x/ week) and flexibility training (2x/week). 2 (Balance training not included)

Studies that have attempted to focus on improving gait speed, have tried to use intensive training strategies. Globas et al11 conducted a program of 3 months with TT 3x/week, starting from 40-50% HRR for 10-20 min to 60-80% HRR for 30-50 min session that resulted in significant gait speed improvements.11 However, the improvements were not large enough for IWS to allow progression from limited community to community ambulation.11 However, increments in training were done by 1 to 5 min/ week and 0.1 to 0.3 km/ hour every 1 to 2 weeks and were based on subject’s tolerance.11 This is unlike, the study performed Pohl et al, who emphasized that if neural plasticity occurs with repeated task specific training, then to improve gait speed, one has to train IWS at increased walking speed.12 He had 3 groups in his study, one was named STT that had high speed on BWSTT, with 10% increase in walking velocity being provided every 10 seconds, at 0% incline.12 The second group was LTT, which also included TT with BWS, but with increments in speed provided at a more relaxed pace of 5% / week and the last group was of conventional gait training.12 All groups worked separately on postural instability.12 Both LTT and STT showed significant improvements with walking speed, cadence, stride length and functional ambulation category, however the improvements with STT > LTT.12 Author feels that Sam should be started with LTT and should gradually be progressed to a program like STT, as unlike the mean gait speed of the subjects in the study by Pohl et al12, Sam’s walking speed is slower.

Another parameter identified by Perry et al. was knee flexion and extension strength, which may limit the ambulation of IWS to household or extend it to community.30 Similar results have been noted by Anderson et al in a 12 week intensive program that included- TT with BWS, strength training at near maximal loads for paretic limb (3 days/wk), aerobic training (2x/week) and functional training (2x/week), where significant improvements with knee flexion and extension with maximal voluntary eccentric, concentric and static contractions were noted, and a concurrent increase in gait speed and gait endurance was also found.15 In a review by Hall et al, lower extremity strengthening was identified as important for IWS rehabilitation, to improve the paretic leg forward propulsion, swing initiation and power generation.17 Improvement in paretic plantarflexors and hip flexors, while concurrent decrease in excess activity at non-paretic knee and hip extensors, were associated with improved walking in IWS.17

Lastly an interesting study was presented by Moore et al, who used Step Activity Monitor (SAM) to study the number of steps taken by IWS and found that they stepped significantly lower than the normal sedentary older adult (step count of 5000-6000 steps /day).13 An intervention to improve step count with TT with BWS resulted in not only improving the step count/day, but also in improving the self-selected and fast walking speed in IWS.12

Motor Learning principles applied: Takeuchi et al. suggest that BWSTT provide the ability to perform a task specific training of an activity, which could be generalized to daily life, in a safe environment. 23 Based on their review, repetitive and intensive task specific training with BWSTT has been associated with neural plasticity, by improving the activation of the brain areas like the caudate nuclei, sensorimotor cortices, and thalamus on the affected side, along with re-organization at the spinal and supraspinal levels, resulting in a decrease in the gait asymmetries and increase in walking speed. 23

1. **If Sam were not eligible to receive direct OP physical therapy services, how could the goals of your intervention be achieved using home program activities and/or community resources?**

To improve gait speed at home or with community resources, Sam should gain access of 2 things, according to the author: (1) A local community fitness center that will provide him with resources like free weights and weight machines, to participate in strength training; and (2) Access to an accelerometer that would count the number of steps that he takes each day.2,13 In the study by Moore et al. BWSTT was used, but during the walking, the therapists provided cues only to increase the step count and not to facilitate any changes in the gait cycle.13 Despite this, there was significant improvement noted in gait speed and endurance, with increase in step count at the end of 4 weeks.13 Fulk et al, in an assessment of 4 accelerometers, identified Step Activity Monitor (SAM) as being valid and reliable for use in IWS for step counting.16 SAM is an accelerometer, worn on leg that counts number of steps taken, through movement of legs.16 SAM has been found to be more expensive than commercially available options, like Fitbit Ultra, but for the latter a minimum walking speed of 0.58 m/s is needed, for which Sam does not qualify.16 However, SAM will be a better choice for Sam, as Sam may have balance deficits, which do not affect the step counting by SAM.16

Further, Sam has depression that may limit him from trying to reach out for community resources and from participating in social situations.18,29 Many organizations are available that provide support for “living with stroke” for both IWS and their caregivers.25,26,27 Sam’s spouse (if, she is his caregiver) can contribute a lot, in motivating him to participate in physical activities.29 She may have to accompany him initially for community activities with a wheelchair, if he is not able to walk long distances, so that Sam could rest in the wheel chair, between his walking. Also, support groups by National Stroke association are present at multiple locations in North Carolina, through which Sam can participate in peer support groups and other social events, which will in turns help him to overcome his own depression and help him to access community resources more.26,29 By using fitness equipment at local gym/ YMCA, walking tracks at YMCA, and neighborhood walks, Sam will have plenty of opportunity to improve his bilateral lower extremity strength and step count, to be able to improve his gait speed to > 0.8 and be able to ambulate in the community.2,13,17, 29,30

References:

* 1. Rehabilitation Measures Database. [www.rehabmeasures.org](http://www.rehabmeasures.org) Accessed 3/22/14.
  2. Gordon NF, Gulanick M, Costa F, et al. Physical activity and exercise recommendations for stroke survivors: An American Heart Association scientific statement from the council on Clinical Cardiology, subcommittee on Exercise, Cardiac Rehabilitation, and Prevention; the Council on Cardiovascular Nursing; the council on Nutrition, Physical activity, and Metabolism; and the Stroke Council. Circulation 2004 Apr 27; 109 (61): 2031-41.
  3. Chen P, Hreha K, Fortis P, et al. Functional assessment of spatial neglect: A review of the Catherine Bergego scale and an introduction of the Kessler foundation neglect assessment process. Top Stroke Rehabil 2012 Sep-Oct; 19 (5): 423-35.
  4. Blennerhassett JM, Dite W, Ramage ER, Richmond ME. Changes in balance and walking from stroke rehabilitation to the community: a follow-up observational study. Arch Phys Med Rehabil 2012 Oct; 93 (10): 1782-7.
  5. Plummer P, Morris ME, Judith D. Assessment of Unilateral Neglect. Physical Therapy August 2003; 83 (8): 732-740.
  6. Berg A, Lonngvist J, Palomaki H, Kaste M. Assessment of depression after stroke: a comparison of different screening instruments. Stroke 2009 Feb; 40 (2): 523-9
  7. Blum L, Korner-Bitensky N. Usefulness of the Berg Balance Scale in stroke rehabilitation: a systematic review. Phys Therr 2008 May; 88 (5): 559-66.
  8. Lin JH, Hsu MJ, Hsu HW, et al. Psychometric comparisons of 3 functional ambulation measures for patients with stroke. Stroke 2010 Sep; 41 (9): 2021-5.
  9. APTA Neurology section. StrokEDGE Taskforce. <http://www.neuropt.org/docs/stroke-sig/strokeedge_taskforce_summary_document.pdf?sfvrsn=2> Last submitted Feb 2011. Accessed 3/23/14.
  10. Bowden MG, Embry AE, Perry LA, Duncan PW. Rehabilitation of walking after stroke. Curr Treat Options Neurol. 2012 Dec; 14 (6):521-30.
  11. Globas C, Becker C, Cerny J, et al. Chronic stroke survivors benefit from high intensity aerobic treadmill exercise: a randomized control trial. Neurorehabil Neural repair 2012 Jan; 26 (1) : 85-95.
  12. Pohl M, Mehrholz J, Ritschel C, Ruckriem S. Speed-dependent treadmill training in ambulatory hemiparetic stroke patients: a randomized controlled trial. Stroke 2002 Feb; 33 (2): 553-8
  13. Moore JL, Roth EJ, Killian C, Hornby TG. Locomotor training improved daily stepping activity and gait efficiency in individuals poststroke who have reached a “plateau” in recovery. Stroke 2010 Jan: 41 (1): 129-35.
  14. Moseley AM, Stark A, Cameron ID, Pollock A. Treadmill training and body weight support for walking after stroke. Cochrane Database Syst Rev 2003; (3): CD002840
  15. Anderson LL, Zeeman P, Jorgensen JR, et al. Effects of intensive physical rehabilitation on neuromuscular adaptations in adults with poststroke hemiparesis. J Strength Cond Res 2011 Oct; 25(10): 2808-17
  16. Fulk GD, Combs SA, Danks KA, et al. Accuracy of 2 activity monitors in detecting steps in people with stroke and traumatic brain injury. Phys Ther. 2014 Feb; 94 (2): 222-9
  17. Hall AL, Peterson CL, Kautz SA, Neptune RR. Relationships between muscle contributions to walking subtasks and functional walking status in persons with post-stroke hemiparesis. Clin Biomech (Bristol, Avon) 2011 Jun; 26(5): 509-15.
  18. Naess H, Lunde L, Brogger J. The effects of fatigue, pain, and depression on quality of life in ischemic stroke patient: the Bergen Stroke Study. Vasc Health Risk Manag. 2012; 8:407-13.
  19. Pendlebury ST, Cuthbertson FC, Welch SJ, et al. Underestimation of cognitive impairment by Mini-Mental State Examination versus the Montreal Cognitive Assessment in transient ischemic attack and stroke: a population-based study. Stroke 2010 Jun; 41 (6): 1290-3
  20. Poole KE, Reeve J, Warburton EA. Falls, fractures, and osteoporosis after stroke: time to think about protection? Stroke 2002 May; 33 (5) : 1432-6.
  21. Fletcher GF, Balady GJ, Amsterdam EA, et al. Exercise standards for testing and training: a statement for healthcare professionals from the American Heart Association. Circulation 2001 Oct 2; 104 (14): 1694-740.
  22. Gracies JM. Pathophysiology of Spastic Paresis. I: Paresis and soft tissue changes. Muscle Nerve 2005 May: 31 (5): 535-51.
  23. Takeuchi N, Izumi S. Rehabilitation with poststroke motor recovery: a review with a focus on neural plasticity. Stroke Res Treat 2013; 2013: 128641.
  24. [www.drugs.com](http://www.drugs.com) Accessed 3/24/14.
  25. . National Stroke Association. Stroke Support Groups. <http://www.stroke.org/site/PageServer?pagename=support_groups> Accessed 3/24/14.
  26. The Internet Stroke Center. Caregiver Introduction. <http://www.strokecenter.org/patients/caregiver-and-patient-resources/caregiver-introduction/> Accessed 3/24/14.
  27. American Stroke Association. Living after Stroke. [http://www.strokeassociation.org/STROKEORG/LifeAfterStroke/Life-After-Stroke\_UCM\_308546\_SubHomePage.jsp Accessed 3/24/14](http://www.strokeassociation.org/STROKEORG/LifeAfterStroke/Life-After-Stroke_UCM_308546_SubHomePage.jsp%20Accessed%203/24/14)
  28. Rimmer JH, Wang E, Smith D. Barriers associated with exercise and community access for individuals with stroke. J Rehabil Res Dev, 2008; 45 (2):315-22.
  29. Stroke Engine <http://strokengine.ca/> Accessed 3/24/14.
  30. Perry J, Garrett M, Gronley JK, Mulroy SJ, Classification of walking handicap in the stroke population. Stroke 1995 Jun; 26 (6): 982-9